LA-UR-21-29918

Title:	General Employee Radiological Training Refresher 47968
Author(s):	Sestokas, Jeffrey Michael Edwards, John Noble Jr.
Intended for:	Training Module
Issued:	2021-10-06

General Employee Radiological Training Refresher 47968

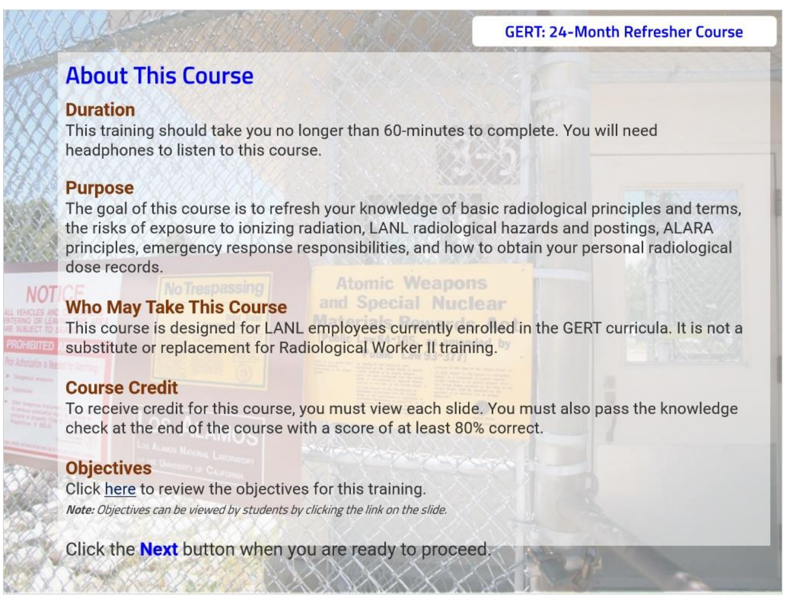
1.1 splash

Notes:

1.2 Introduction

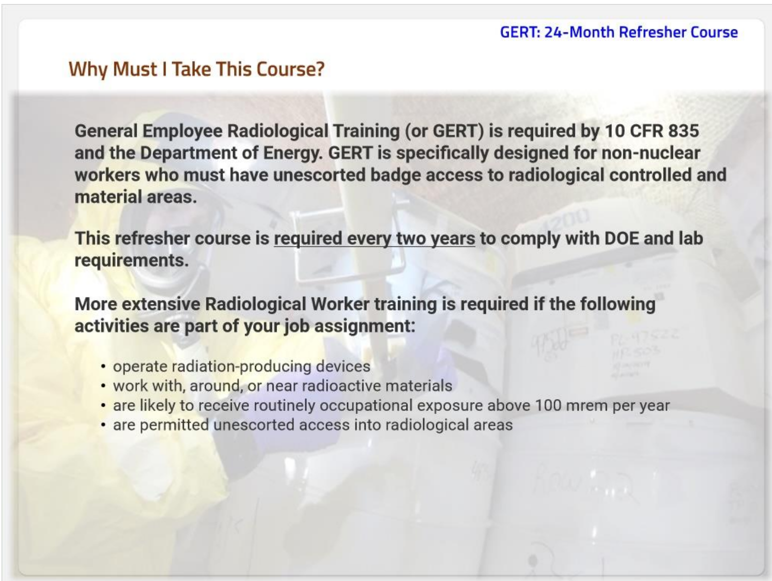
Notes:

1.3 Course Intro

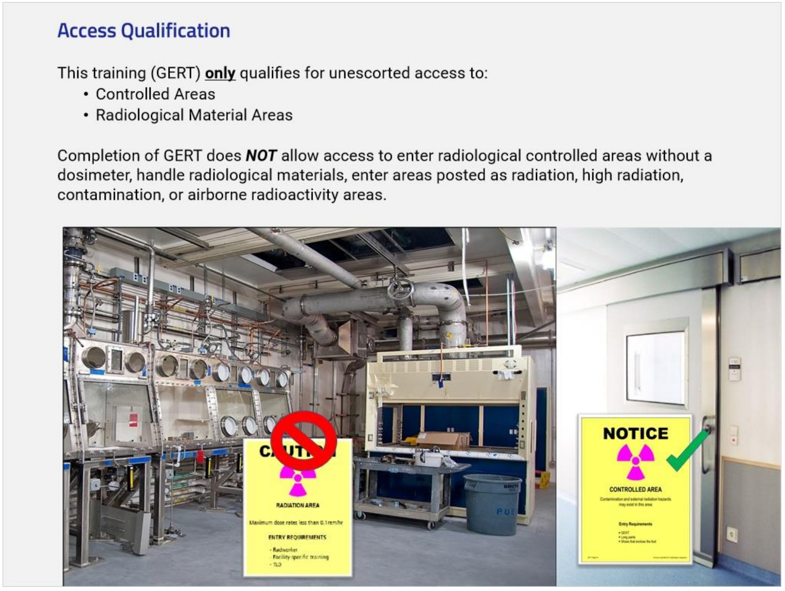


Narration: Welcome to the General Employee Radiological Training or GERT course. This training is designed to refresh knowledge of basic radiological principles and terms, the risks from exposure to ionizing radiation, LANL's radiological hazards and postings, ALARA methods, your responsibilities during emergencies, and how to obtain your personal radiological dose records.

1.41 Rationale

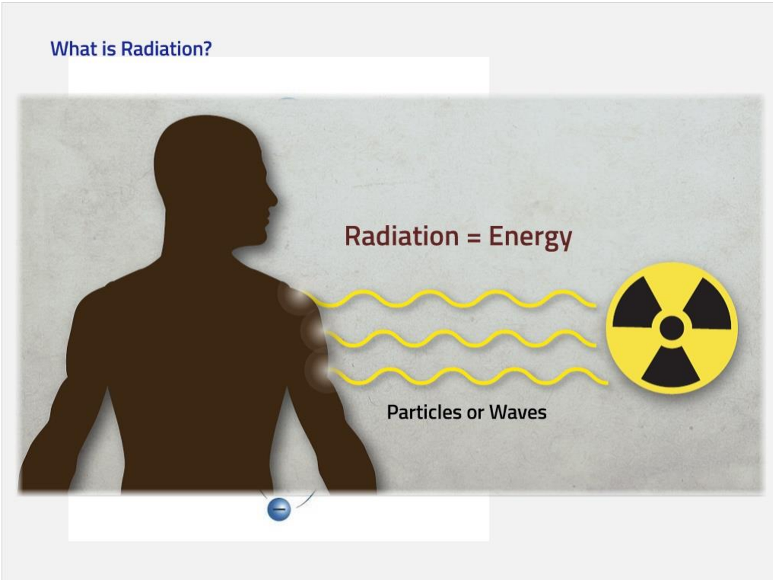


1.4 Access Qualification



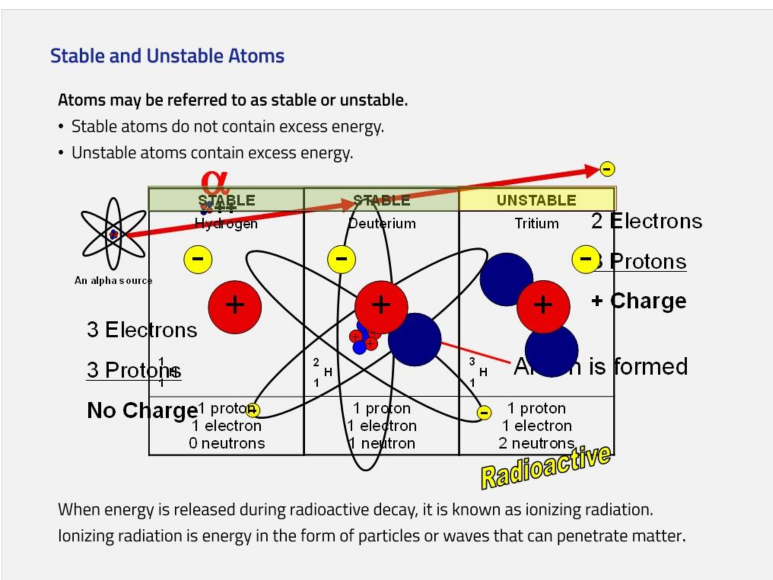
Narration: When you complete GERT, you will be qualified to access controlled areas at LANL without an escort and have the general radiological knowledge common to all DOE sites. However, completion of GERT does not allow you to enter radiological controlled areas without a dosimeter, handle radiological materials, enter areas posted as radiation, high radiation, contamination, or airborne radioactivity areas.

1.5 What is Radiation



Narration: Radiation is energy in the form of particles or waves. The fundamental unit of matter is the atom. Each atom is made up of three components that determine the atom's physical and chemical properties. Located in the nucleus, protons are positively particles that determines the element type. Neutrons are also found in the nucleus and have no charge but are needed for stability. Finally, electrons orbit the atom and have a negative charge.

1.6 Stable and Unstable atoms

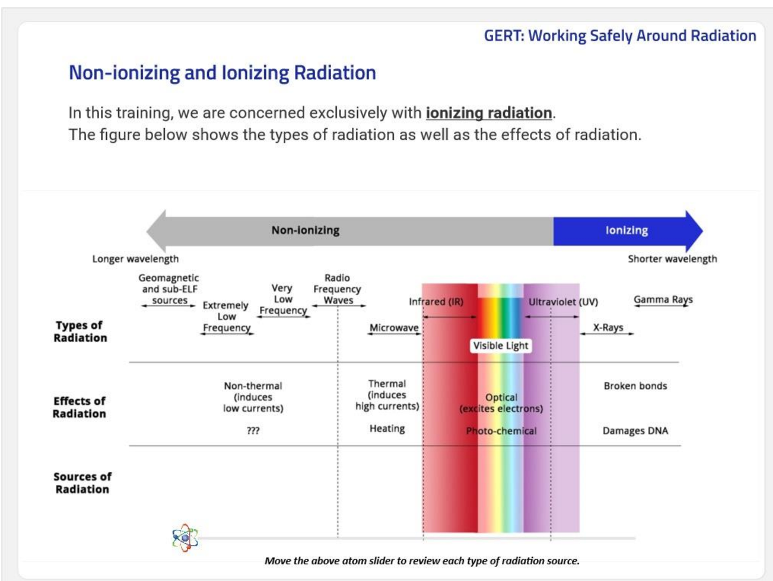


Narration: What's the difference between stable and unstable atoms?

Atoms may be referred to as stable or unstable (that is radioactive) atoms. Stable atoms do not contain excess energy. Unstable atom contains excess energy. This is caused by an imbalance of the ratio of protons and neutrons in the atom's nucleus. These atoms release their energy in process known as radioactive decay.

When energy is released during radioactive decay that can remove an electron from an atom it is known as ionizing radiation. Once again, ionizing radiation is energy in the form of particles or waves that can penetrate matter.

1.7 Ionizing and Nonionizing Radiation



Narration:

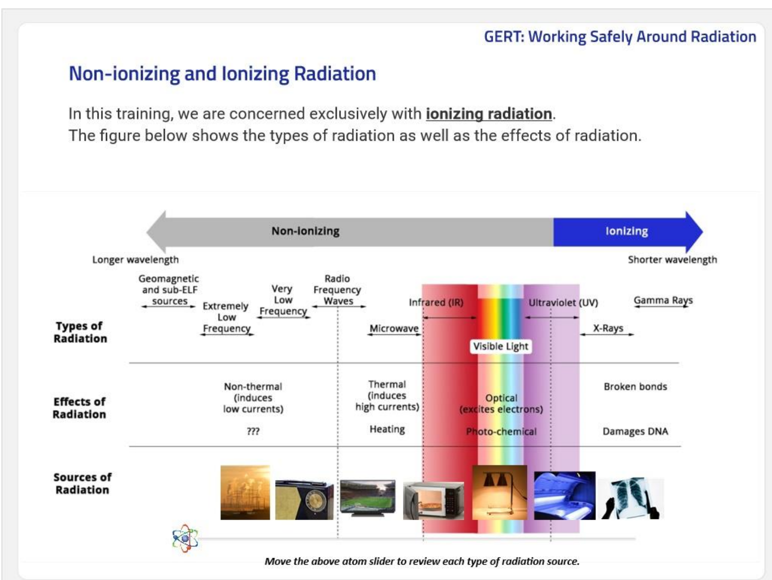
Radioactivity is the physical property, or capability of certain atoms to emit radiation as they decay or disintegrate. These radioactive atoms can be either be naturally occurring or man-made.

Radiation that does not contain enough energy to strip electrons from atoms is known as nonionizing radiation.

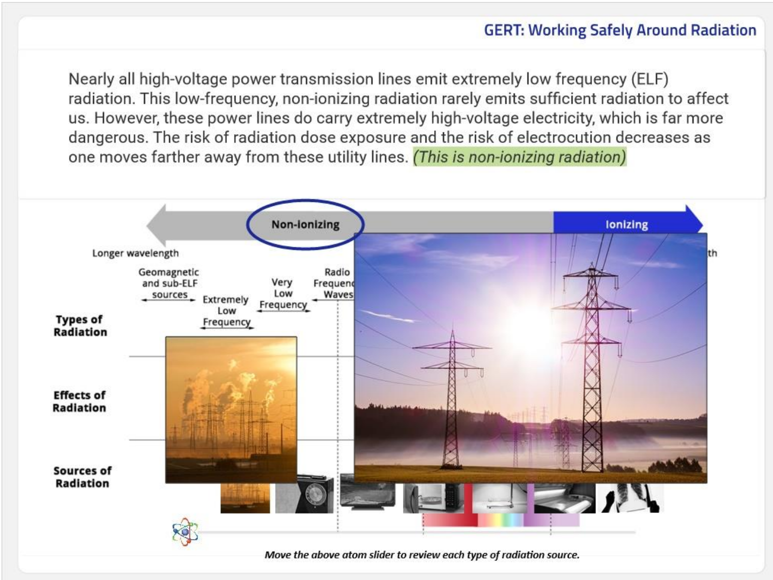
Conversely, when radiation contains enough energy to strip electrons from atoms it is known as ionizing radiation.

Move the slider to view examples of non-ionizing and ionizing radiation types.

Start (Slide Layer)

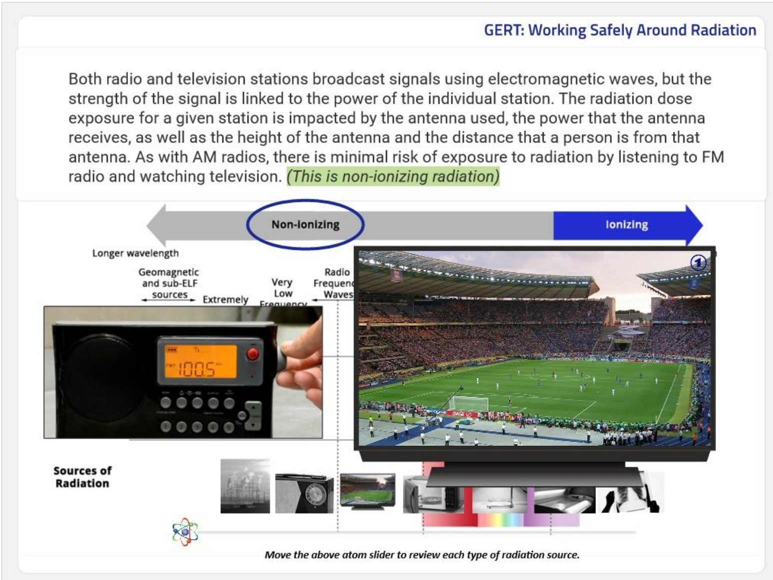


power_line (Slide Layer)

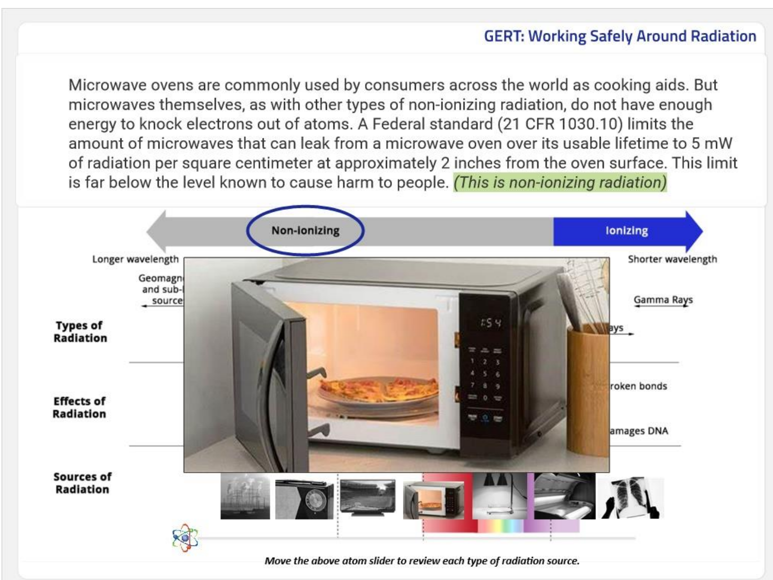


AM_radio (Slide Layer)

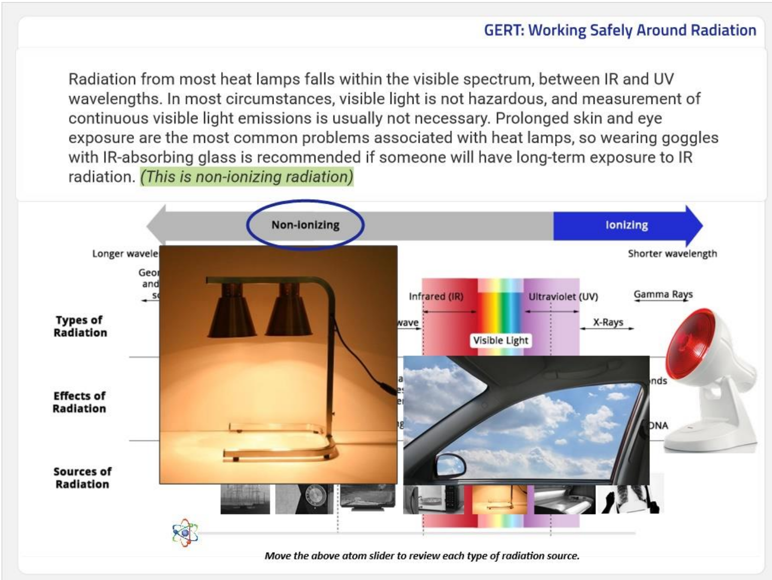
FM_radio (Slide Layer)



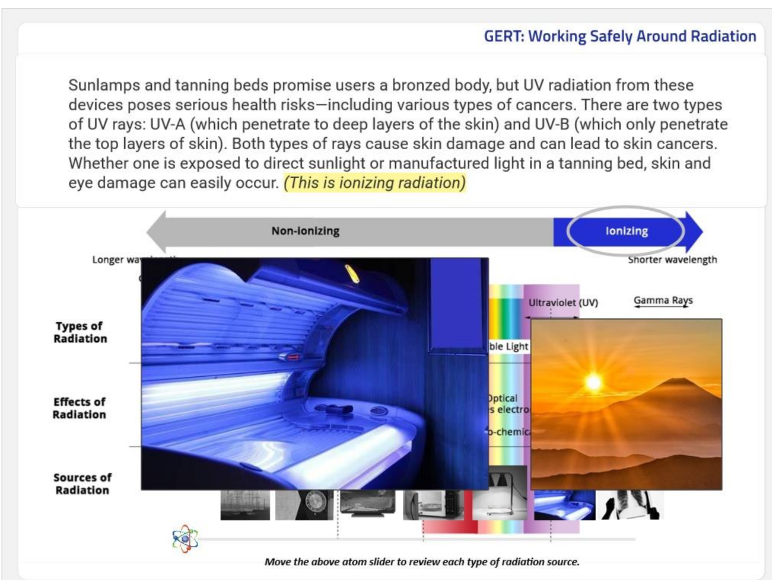
uwave (Slide Layer)



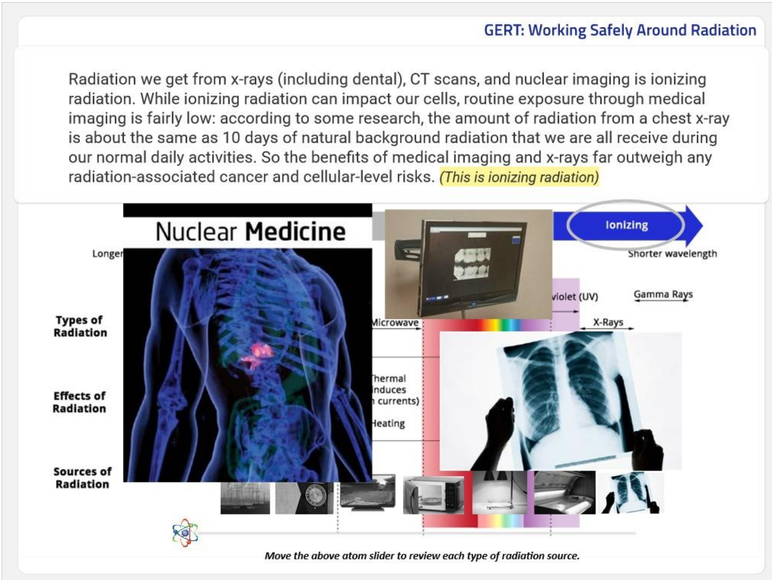
heat_lamp (Slide Layer)



tanning (Slide Layer)



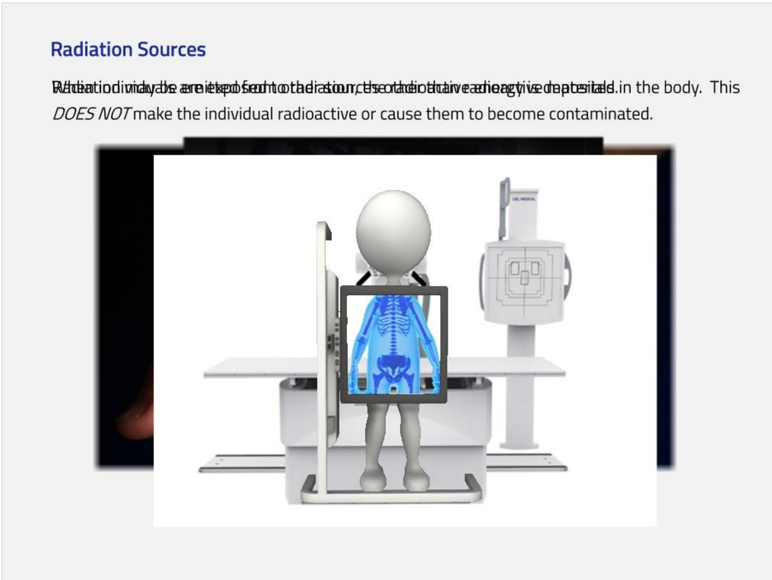
medical (Slide Layer)



1.8 radioactive contamination

Narration: Radioactive materials are any material that contains unstable atoms that emit radiation. Radioactive material may exist in any physical form including as a solid, liquid, or gas. When radioactive material is transferred or easily spread to surfaces or the atmosphere it is known as radioactive contamination. A simplified definition of radioactive contamination is radioactive material in an unwanted location.

1.9 Radiation Sources



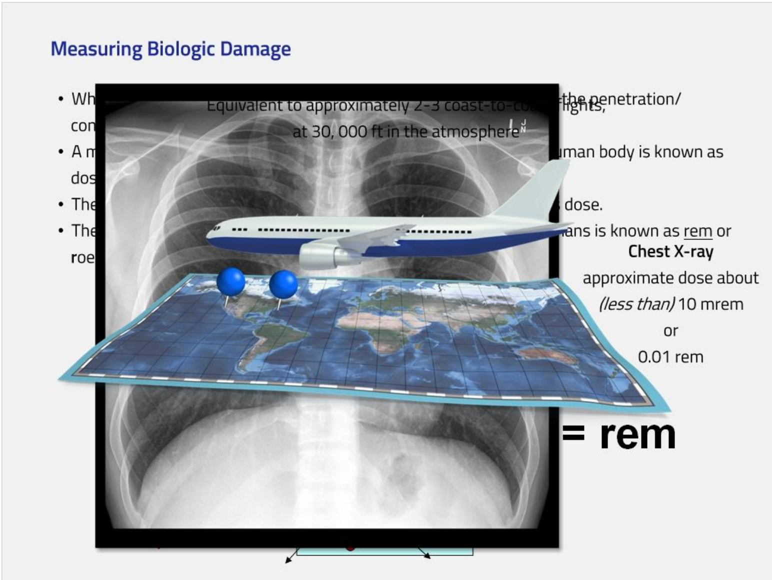
Narration:

Radiation may be emitted from other sources other than radioactive materials. Xray machines for example have certain physical processes that may cause the production of ionizing radiation. The operation of accelerators like the one found at TA-53 can also cause the production of ionizing radiation and material.

When individuals are exposed to radiation, the radioactive energy is deposited in the body. This does not make the individual radioactive or cause them to become contaminated.

Let's say you took your smart phone's flashlight to your hand. Your hand would absorb the light, and there may be some heating on bodily tissue; however, your hand doesn't become a light source or emit light due to absorption.

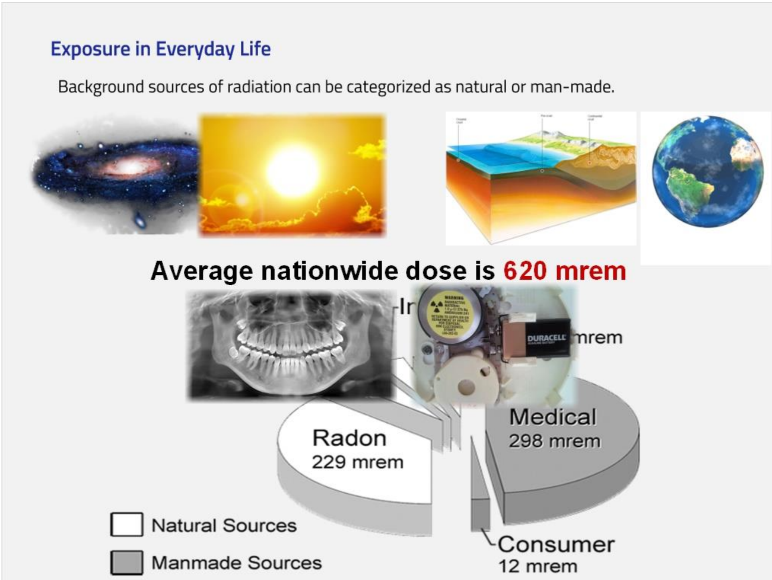
1.10 Measuring Biologic Damage



Narration: When your body absorbs radiation, your tissue may be damaged by the penetration and conversion of the radioactive energy. A method for monitoring and measuring radiation damage to the human body, and to ensure it's kept to a minimum, is known as dosimetry. The amount of radioactive energy absorbed in the body is known as dose. The special unit for measuring radiation in humans is known as rem or roentgen equivalent to man. The rem is a unit for equating radiation absorption with biological damage.

Since the REM is a large unit of measurement, radiation exposure is recorded in thousands of a rem or millirem. For instance, let's say you go to the doctor to receive a chest x-ray the approximate dose would be about (less than) 10 mrem or 0.01 rem. The same amount would be equivalent to approx. 2-3 coast-to-coast flights, at 30, 000 ft in the atmosphere, from elevated cosmic radiation levels in the upper atmosphere. In the next lesson, we will discuss natural and man-made sources of radiation.

1.11 Exposure in everyday life

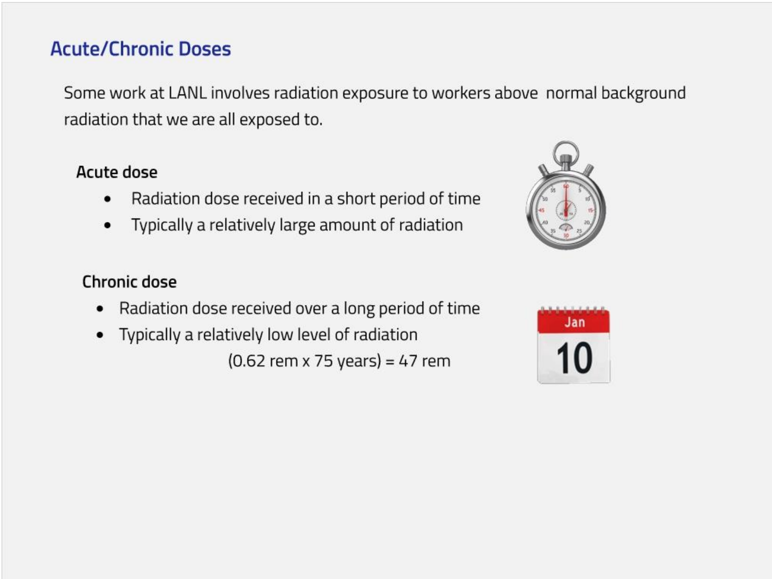


Narration: Humans are always exposed to radiation from background sources; however, most are not exposed as a consequence of their occupation. Background sources of radiation can be categorized as natural or man-made.

Exposure to natural background cosmic radiation comes from the sun and outer space. Natural terrestrial background radiation comes from the earth's crust from rocks, soils, and radon. Man-made sources of radiation come from medical and dental x-rays, nuclear medicine, and consumer products such as the americium-241 in smoke detectors or thorium found on lantern mantels.

In the United States, your average background radiation dose is 620 mrem per year (Show the composite graphic)

1.12 Acute/Chronic Doses

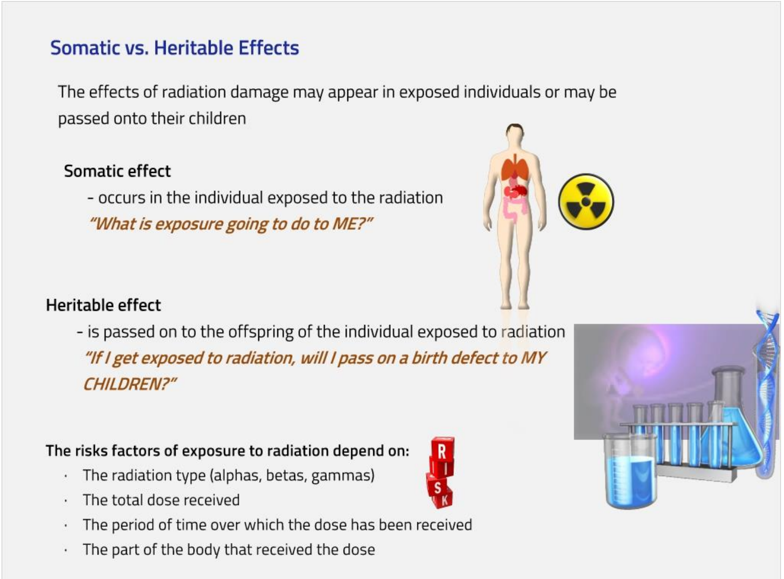


Narration: Some work at LANL involves radiation exposure to workers above the normal background radiation that we are all exposed to.

Large doses received in short periods of time otherwise known as acute doses can cause a range of serious injuries and/or death. We also know that large doses of radiation may cause increase in some forms of cancer. Large doses are not received as a result of occupational exposure here at LANL. Stringent dose limits prevent measurable increases in radiological effects from chronic doses, or small doses received over a long period of time.

The risks associated with occupational radiation doses are considered acceptable in comparison with other occupational risks.

1.13 Somatic vs. Heritable Effects



Narration:

The effects of radiation damage may appear in exposed individuals or may be passed on to their children.

Effects that present directly in exposed individuals are known as **somatic effects**. When the effects indirectly present in the children of the exposed person, these are called **heritable effects**.

No heritable effects in children of exposed persons have been observed in populations that have been clearly linked to chronic, low-level exposure.

The risks factors of exposure to radiation depend on:

- The radiation type (alphas, betas, gammas)
- The total dose received
- The period of time over which the dose has been received
- The part of the body that received the dose

1.14 Prenatal Risks

Narration: Radiation exposure is extremely detrimental for an embryo or developing fetus because embryotic or fetal cells rapidly divide. High dose radiation exposure can result in miscarriage, low birth weight, mental retardation, birth defects, and increased risk of developing cancer and other diseases.

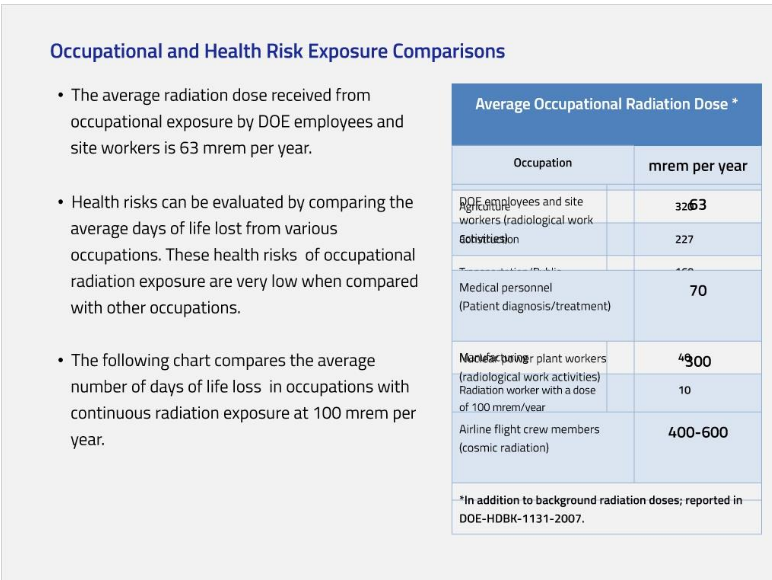
Because the effects of low doses radiation exposure are not precisely known it is wise to avoid any unnecessary radiation exposure during pregnancy.

If you are pregnant, and have the potential for exposure to radiation in the workplace, you're encouraged to notify your supervisor and/or Occupational Medicine (OM) in writing.

The Reproductive Health Assistance Program or RHAP will evaluate your work situation to determine if your job tasks must be modified to minimize exposure and will provide the option for temporary job reassignment.

You are protected from discrimination by Title VII of the Civil Rights Act of 1964 while on reassignment to which occupational radiation exposure is unlikely.

1.15 Occupational and Health Risk Exposure Comparisons

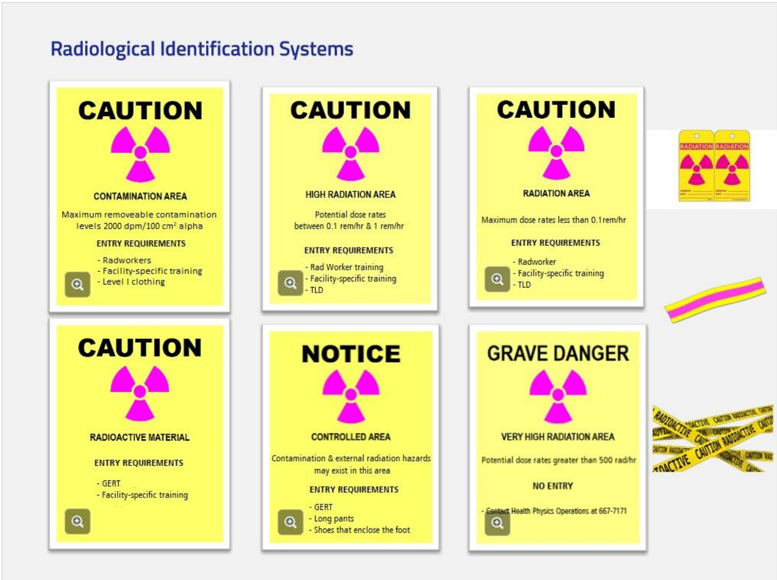


Narration: The average radiation dose received from occupational exposure by DOE employees and site workers is 63 mrem per year. The following chart compares this amount with the average radiation doses received by workers in other occupations

Health risks can be evaluated by comparing the average days of life lost from various occupations. The health risks of occupational radiation exposure are very low when compared with other occupations.

The following chart compares the average number of days of life loss in occupations with continuous radiation exposure at 100 mrem per year.

1.16 Radiological Identification Systems



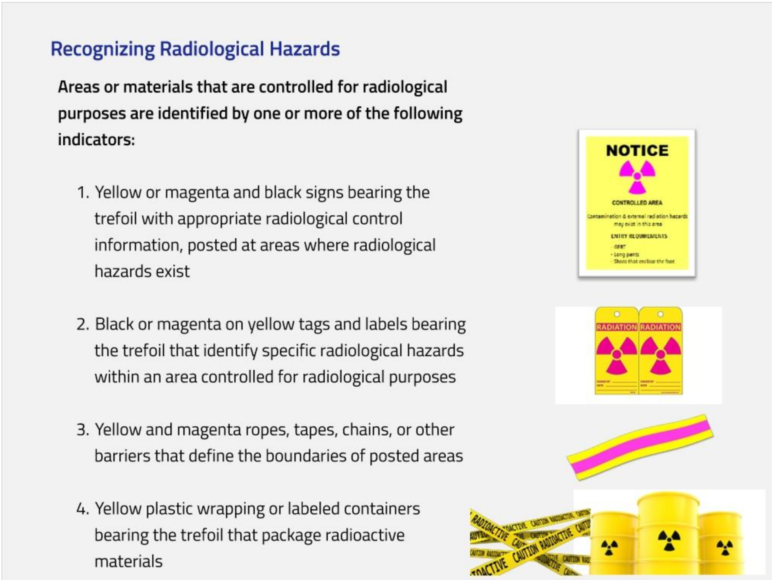
Narration: LANL uses various radiological identification systems and controls to protect workers from exposure to radiation.

All areas, materials, and machines that are controlled for radiological purposes are identified by posted signs, tags, or labels, combined with physical barriers where appropriate.

The universal symbol for radiation otherwise known as the (trefoil), has distinguishing color combinations of black or magenta on a yellow background that helps to make radiological hazards easy to recognize.

Radiological workers may not place, modify, relocate, or remove any radiological posting throughout the lab. Only Radiological Control Technicians and authorized Health Physics staff may perform those activities. If postings are incorrect or missing, contact the RCT and do not enter thearea until the issue is resolved.

1.17 Recognizing radiological hazards

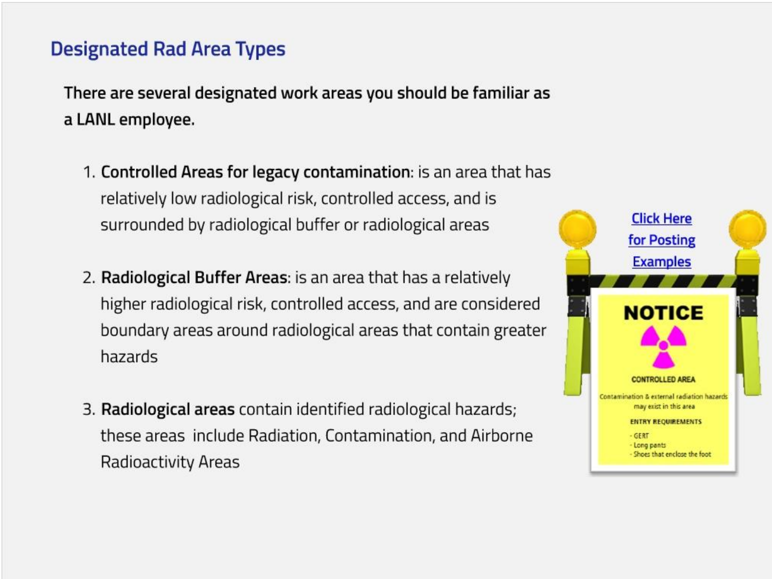


Narration: Areas or materials that are controlled for radiological purposes are identified by one or more of the following indicators:

1. Yellow or magenta and black signs bearing the trefoil withappropriate radiological control information, posted at areas where radiological hazards exist
2. Black or magenta on yellow tags and labels bearing the trefoil that identify specific radiological hazards within anarea controlled for radiological purposes
3. Yellow and magenta ropes, tapes, chains, or otherbarriers that define the boundaries of posted areas
4. Yellow plastic wrapping or labeled containers bearing thetrefoil that package radioactive materials

Established by DOE 10 CFR 835, areas controlled for radiological purposes are based on the potential for external radiation exposure and/orthe potential for contamination. At LANL, signs for these areas have a black or magenta trefoil with black lettering on a yellow background. Specific signs for each area alert workers to the type and/or level of radiation present.

1.18 Designated Rad Area Types



Narration: There are several designated work areas you should familiar with as a LANL employee.

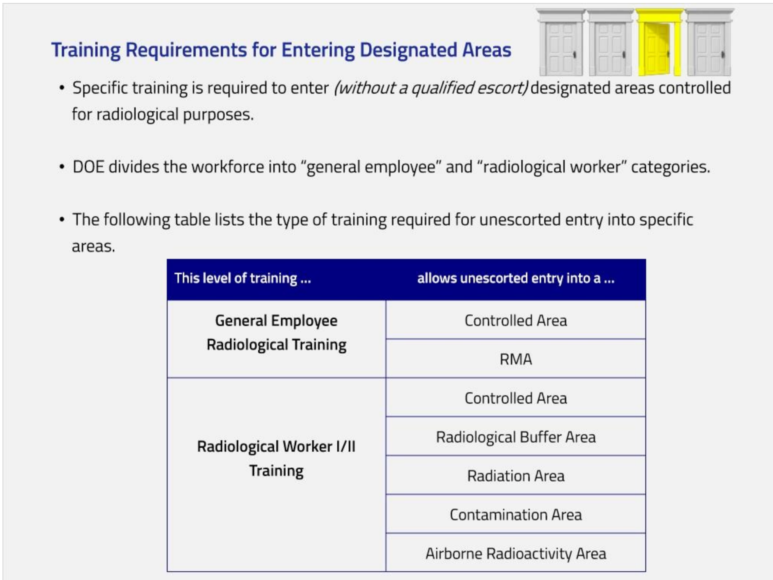
1. Controlled Areas for legacy contamination is an area that has relatively low radiological risk, controlled access, and is surrounded by radiological buffer or radiological areas
2. Radiological Buffer Areas is an area that has a relatively higher radiological risk, controlled access, and are considered boundary areas around radiological areas that contain greater hazards
3. Radiological areas contain identified radiological hazards; these areas include Radiation, Contamination, and Airborne Radioactivity Areas

Some radiological areas are controlled for legacy contamination. In these areas, no accessible contamination is known to exist, but contamination may be present in programmatic systems, under paint, orin other inaccessible areas within the facility or area.

When complete historical knowledge is in question or when radionuclides are known to be present, employees should obtain approval from Radiation Protection Operations before working on or breaching facility systems, surfaces, or programmatic equipment. Contact the area RCT prior to removal of items or equipment from areas controlled for legacy contamination.

To help you identify radiological postings you will see while working here at LANL, here are some examples

1.19 Training Requirements for Entering Designated Areas



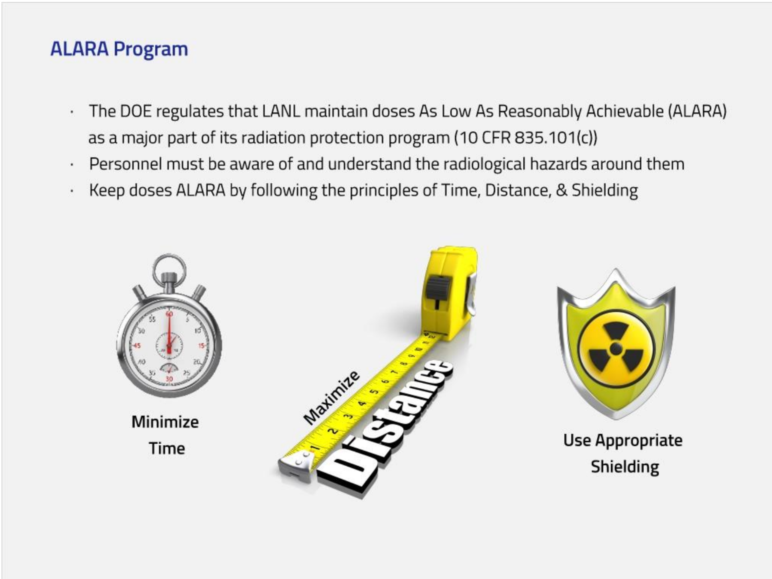
This level of training ...	allows unescorted entry into a ...
General Employee Radiological Training	Controlled Area
	RMA
Radiological Worker I/II Training	Controlled Area
	Radiological Buffer Area
	Radiation Area
	Contamination Area
	Airborne Radioactivity Area

Narration:

Specific training is required to enter (without a qualified escort) designated areas controlled for radiological purposes. DOE divides the workforce into "general employee" and "radiological worker" categories. The following table lists the type of training required for unescorted entry intospecific areas.

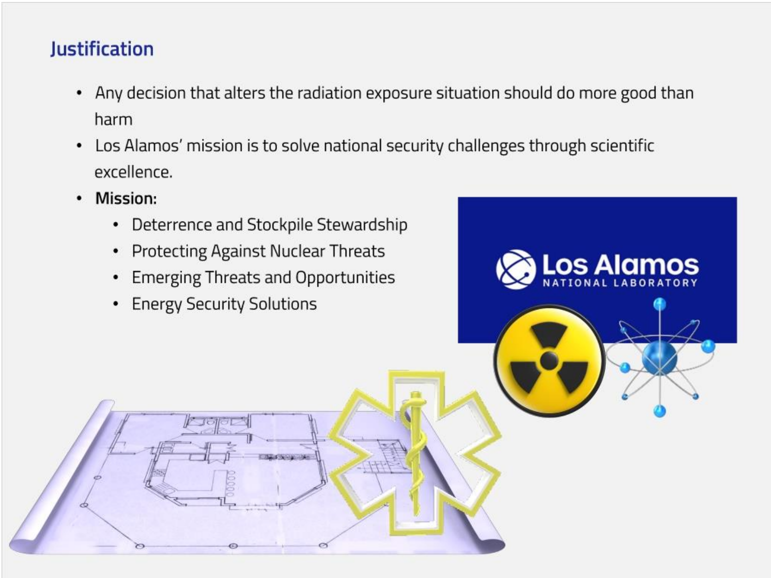
Additional entry requirements may exist for access to areas controlled for radiological purposes. Additional facility-specific trainingmay be required at individual facilities throughout the Laboratory.

1.20 ALARA Program



Narration: Los Alamos National Lab is expected to keep occupational dose from radiation and radioactive material as low as reasonably achievable through the performance of all site activities. Exposures that result in dose to personnel must be justified based on the work that is being performed. Employees are expected to keep their dose reasonably low by understanding where radiological hazards exist and by following a few basic principles while working around radiation and radioactive material.

1.21 Justification



Narration: Our laboratory allows for reasonable occupational exposure to radiation and radiological material based on our mission and the work we perform. The mission of the laboratory is to solve national security challenges through scientific excellence. The listed benefits must justify our actions to allow us to take on dose.

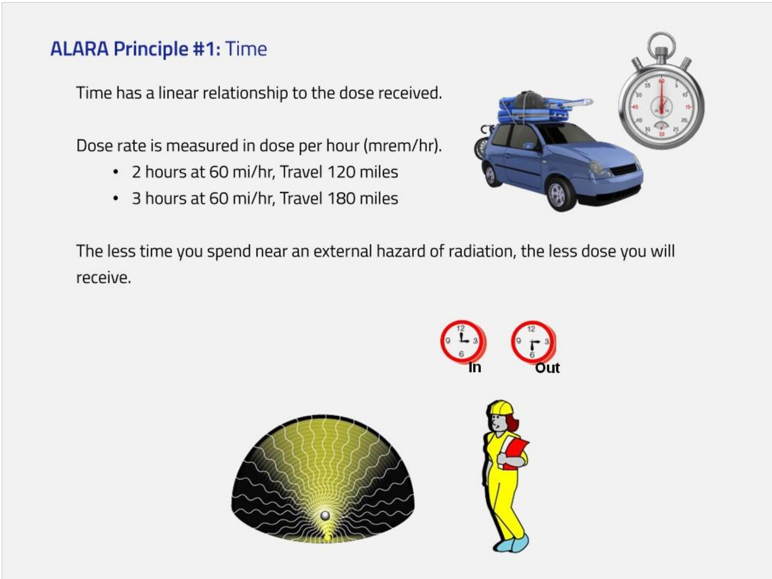
We are able to justify our work with radiation and radiological material in two ways. First, we consider planned activities and their impact on occupational and public exposures. Second, we consider routine and emergency exposure situations where pathways of exposure would impact the dose received by occupational workers and the public.

1.22 Reducing External Dose

Narration: Although there is justification for occupational exposure, we can still do more to ensure that individuals doses received are As Low As Reasonably Achievable (or ALARA); meaning well below the limitation that is set by the DOE.

To protect ourselves from and during exposure situations, employees should be aware of their surroundings and the radiological hazards that could be present around them. By minimizing the time, maximizing the distance, and using existing or temporary shielding around sources of radiation that are external exposure hazards, personnel will keep their doses low.

1.23 ALARA Principle #1: Time

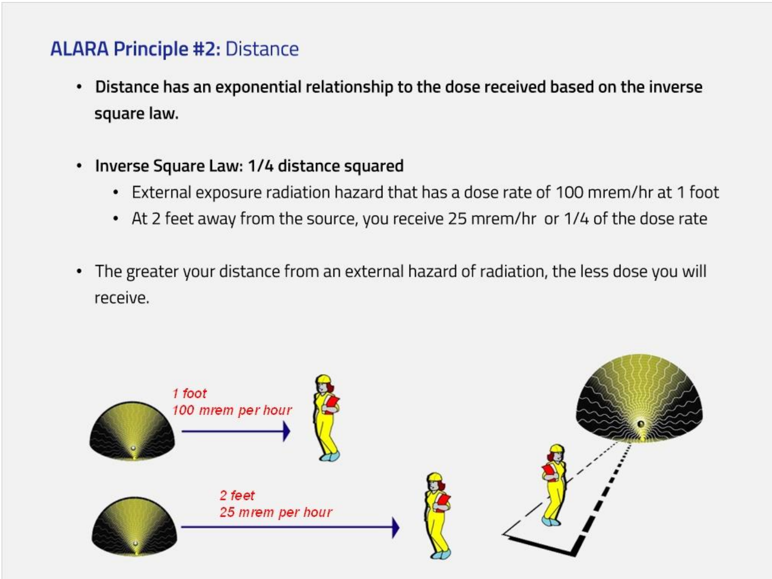


Narration: To begin our discussion on ALARA or As Low As Reasonable Achievable, let's explore how time would affect the amount of dose that an individual would receive. When considering external exposure hazards, we measure the dose rate that a radiation source emits while standing in a specific location.

For instance, let's say you were to stand in place for an hour where there is a dose rate of 10 mrem/hr, in turn you would receive 10 mrem of dose. Now, let's say you were to stick around for two hours, your dose would double to 20 mrem because you were standing in the same location for twice the duration. Time has a linear effect on the dose that you receive. Another way to think about the time vs dose concept, is if you go on a road trip. Your speed is like the dose rate you receive. If you travel at 60 mi/hr for two hours, you will have gone 120 miles. Add another hour on the road, and you will have gone another 60 miles, or 180 miles.

Consider that the less time that you spend around an external hazard of radiation, the less dose you will receive.

1.24 ALARA Principle #1: Distance



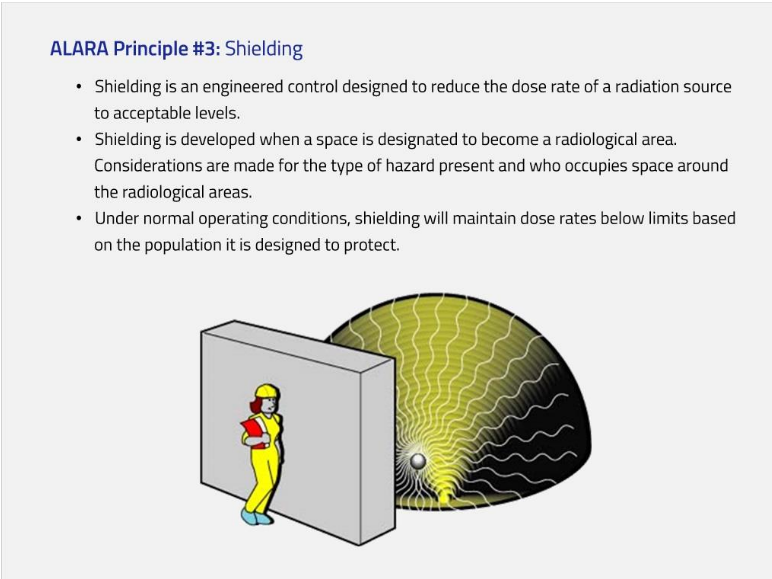
Narration: There is an exponential relationship with distance from a radiation source, and the dose rate you would be exposed to. This means that there is an even greater effect on the dose that you would receive by increasing your distance from a source of radiation than by spending less time around that source of radiation.

Inverse Square Law: 1/4 distance squared

- For an external exposure radiation hazard that has a dose rate of 100 mrem/hr at 1 foot.
- At 2 feet away from the source, you receive 25 mrem/hr or 1/4 of the dose rate

The greater your distance from an external hazard of radiation, the less dose you will receive.

1.25 ALARA Principle #3: Shielding

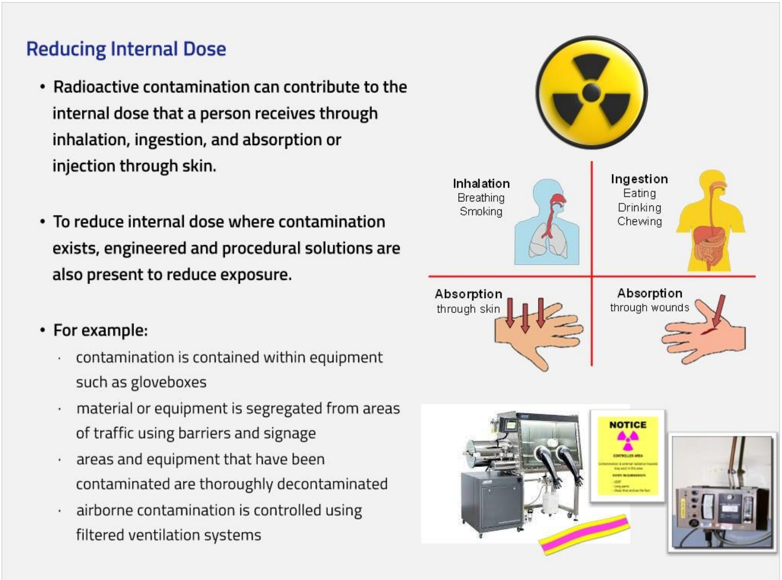


Narration:

The final ALARA principle we will discuss in this course is shielding. Shielding is an engineered solution for reducing the exposure rate of sources. Shielding can be designed to be installed around high-exposure sources (either permanently or temporarily), or it can be incorporated in room walls that sources are housed in.

Shielding can be designed to reduce the dose rate to acceptable levels within or outside of radiological areas based on occupancy limits.

1.26 Reducing Internal Dose



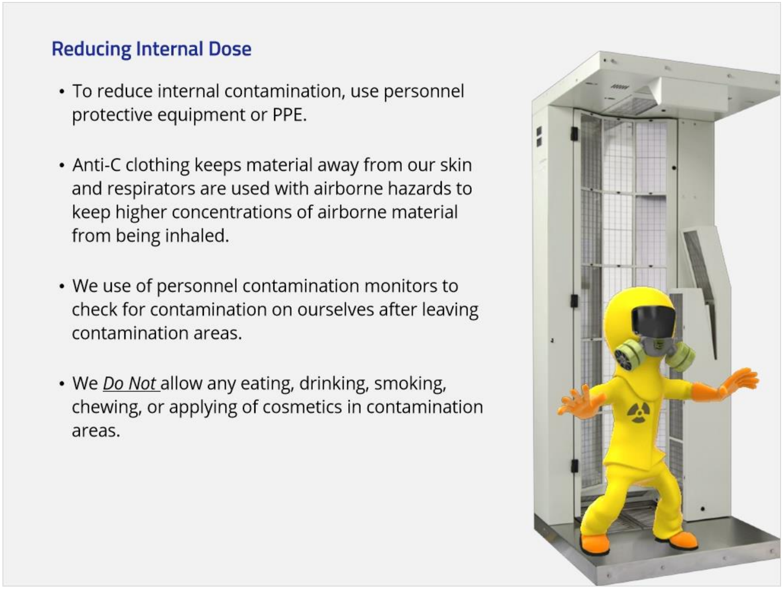
Narration: Radioactive contamination can contribute to the internal dose that a person receives through inhalation, ingestion, and absorption or injection through skin. In order to reduce the int

ernal dose one receives, there are a number of controls in place and that may be employed by personnel. In areas where contamination exists, engineered and procedural solutions are also present to reduce exposure. For example,

- contamination is contained within equipment such as glove boxes,
- it is segregated from areas of traffic using barriers and signage,
- areas and equipment that have been contaminated are thoroughly decontaminated
- airborne contamination is controlled using filtered ventilation systems.

As you recall, please refer to the radiological identification systems in the previous lesson for examples postings, signs, and labels

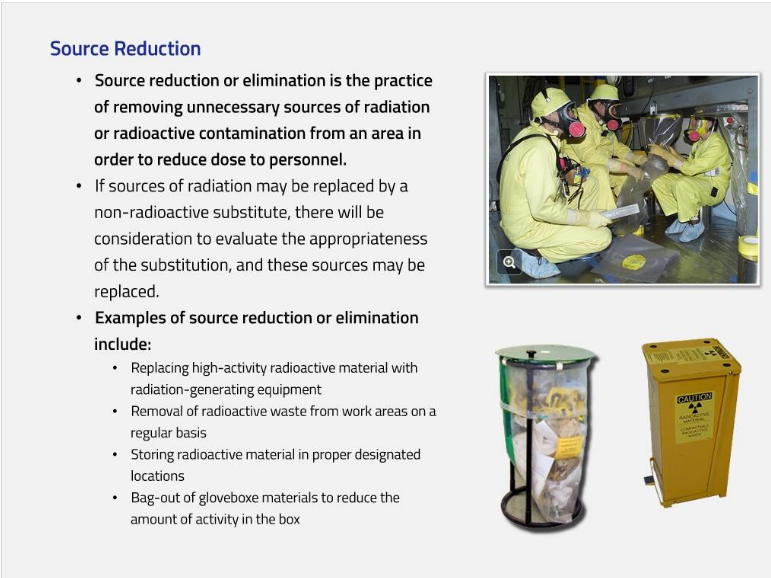
1.27 Reducing Internal Dose cont.



Narration: Another way to significantly reduce internal contamination is through the proper use of personnel protective equipment or PPE. When used properly, we are able to control the interaction that loose radioactive material has with our bodies. Anti-C clothing keeps material away from our skin and respirators are used with airborne hazards to keep higher concentrations of airborne material from being inhaled. Further, we use personnel contamination monitors to check for contamination on ourselves after leaving contamination areas.

Policy states that we do not allow any eating, drinking, smoking, chewing, or applying of cosmetics in contamination areas. Following these policies helps us protect you from ingesting material as it comes into contact with our mouths.

1.28 Source Reduction



Narration:

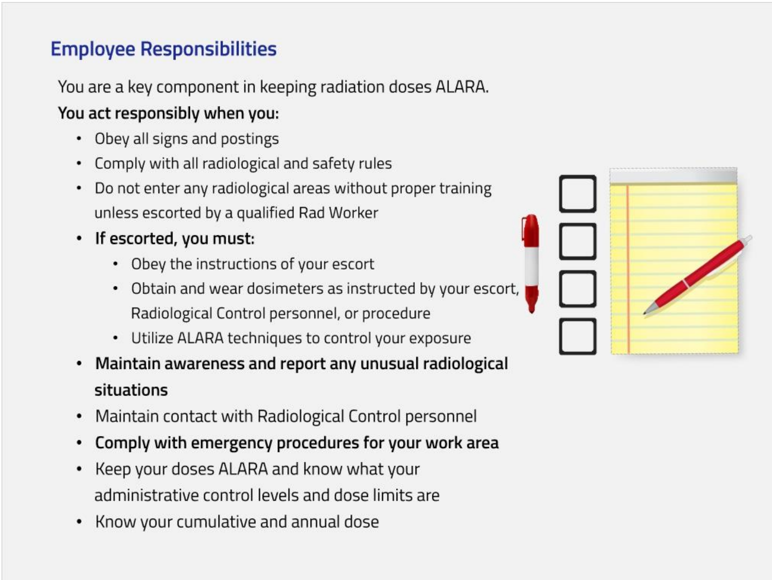
Source reduction or elimination is the practice of removing unnecessary radiation or radioactive contamination from an area in order to reduce dose to personnel.

If sources of radiation may be replaced by a non-radioactive substitute, there may be an evaluation concerning the appropriateness of the substitution, and these sources may be replaced.

Some examples of source reduction or elimination include:

- Replacing high-activity radioactive material with radiation-generating equipment
- Removal of radioactive waste from work areas on a regular basis
- Storing radioactive material in proper designated locations
- Bag-out of glovebox materials to reduce the amount of activity in the box

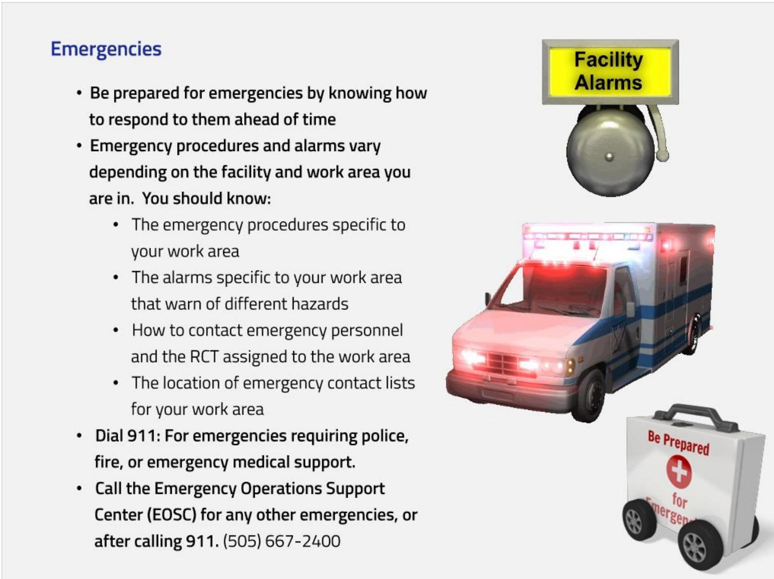
1.29 Employee Responsibilities



Narration: Each and every employee has the potential to impact the ALARA program at Los Alamos National Lab. Remember that you are responsible for your dose and the impact you have on the dose of others. Awareness of your situation is important for your understanding of what is going on around you. Make sure that you comply with all signs, postings, and rules related to the areas you visit.

Do not enter areas that you are not permitted to go, and know what those areas are. If you are not permitted unescorted access to an area, understand that you must be escorted through these areas by a knowledgeable escort, and that you are required to obey and follow the instructions of your escort. Always keep the principles of ALARA in mind and know your dose limits.

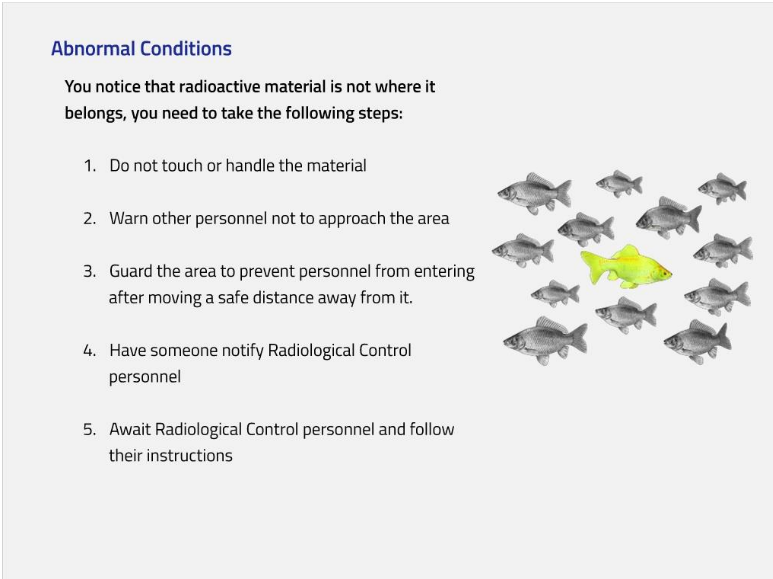
1.30 Dealing with Emergencies



Narration: The best time to know how to deal with emergencies is before one occurs, so it is important to take preventive measures by familiarizing yourself with emergency procedures, alarms, and contact information ahead of time.

You are responsible for your understanding of how to properly deal with emergency situations. During emergencies, the environment can be confusing and chaotic. If you are well informed of how to respond, you will be confident in your actions and will facilitate smooth emergency response.

1.31 Abnormal Conditions

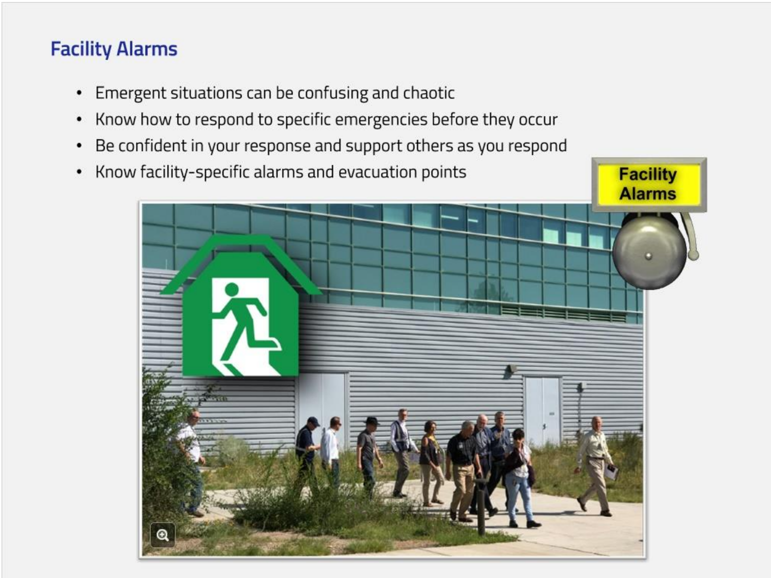


Narration: Here's an important question. What would you do if you notice that there is radioactive material missing or out of place? The answer is, you could be in the middle of a hazardous situation, so immediate action is important.

First, make sure that you do not try to touch or handle the material on your own.

Second, make sure that other people are aware of the situation and that you all get a safe distance away from the material. While guarding the area, send someone to contact Radiological Control Technician so that they may respond to the situation. Comply with all instructions that are given by the Radiological Control personnel.

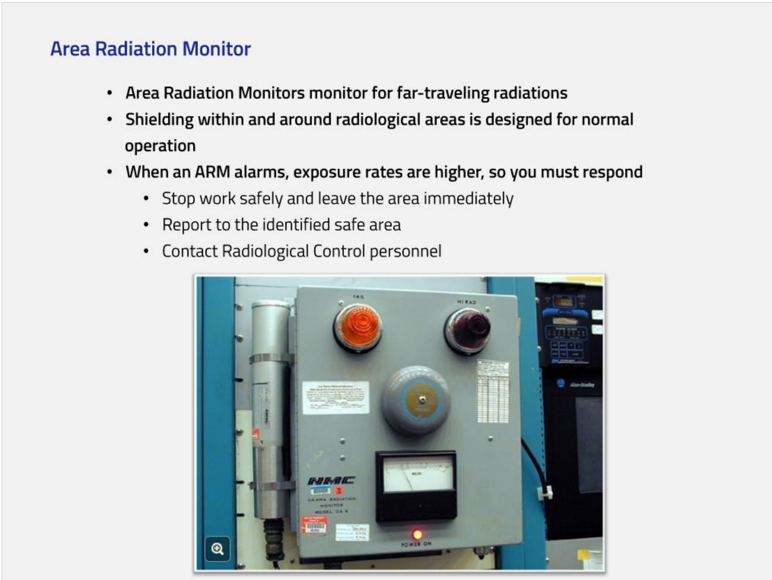
1.32 Facility Alarms



Narration: During an emergency situation, you must be confident to act appropriately. When an alarm sounds, there may be confusion from others around you, so being aware of the different types of radiological alarms and how you should respond to them ahead of time will be vital for your response as well as the support of others.

There are two radiological alarms that we will discuss: the Area Radiation Monitor (ARM alarm) and the Continuous Air Monitor (CAM alarm). Be aware that these alarms may sound different between LANL facilities, so you will want to work with the RCT assigned to specific facilities to understand what each alarm sounds like. Radiological Control personnel will also inform you as to where you should evacuate to for each alarm.

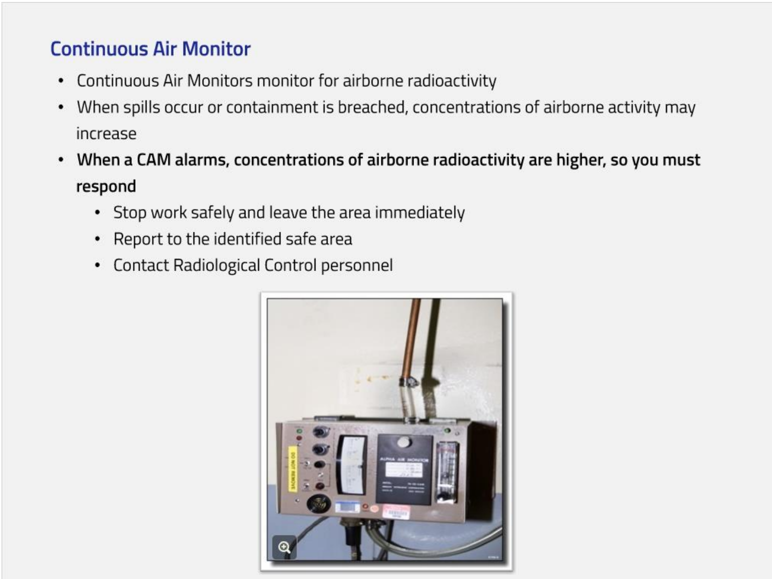
1.33 Area Radiation Monitor



Narration:

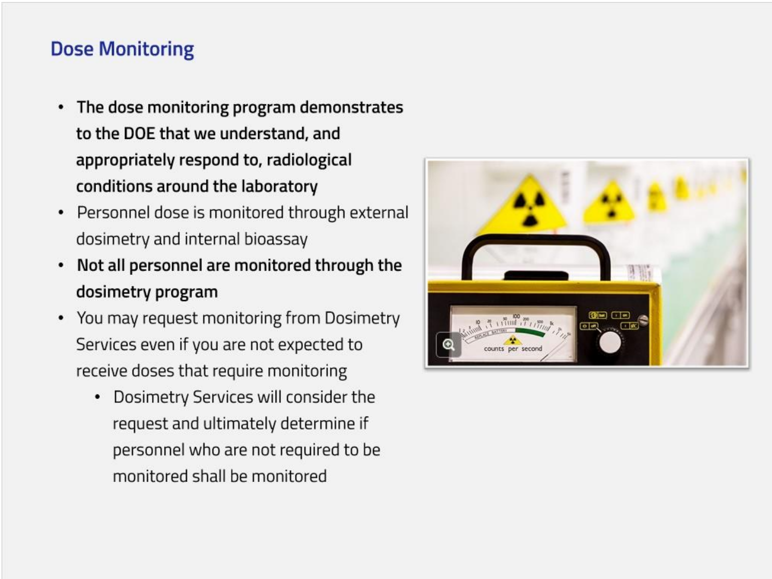
The Area Radiation Monitor or ARM alarm is used to measure far-traveling radiations, such as gamma, x-ray, and neutron radiation. These monitors measure the exposure rates at their locations, and will sound an alarm once the exposure rate reaches past suspensions levels. Shielding protecting areas outside of and within radiological areas are designed to keep doses well below laboratory limits. So if you hear an ARM alarm, evacuate immediately to a controlled area or anti-c assembly area.

1.34 Continuous Air Monitor



Narration: The Continuous Air Monitor or CAM alarm is used to measure the internal hazard of airborne radioactivity present in a volume of air. Airborne radioactivity emits radiation. These monitors measure the airborne concentrations at their locations, and will sound an alarm once concentrations reach suspension levels that suggest the situation has changed. If you hear a CAM alarm, it means that radiation may have become aerosolized. You must evacuate immediately to a controlled or anti-c assembly area if you hear this alarm sounding.

1.35 Dose Monitoring

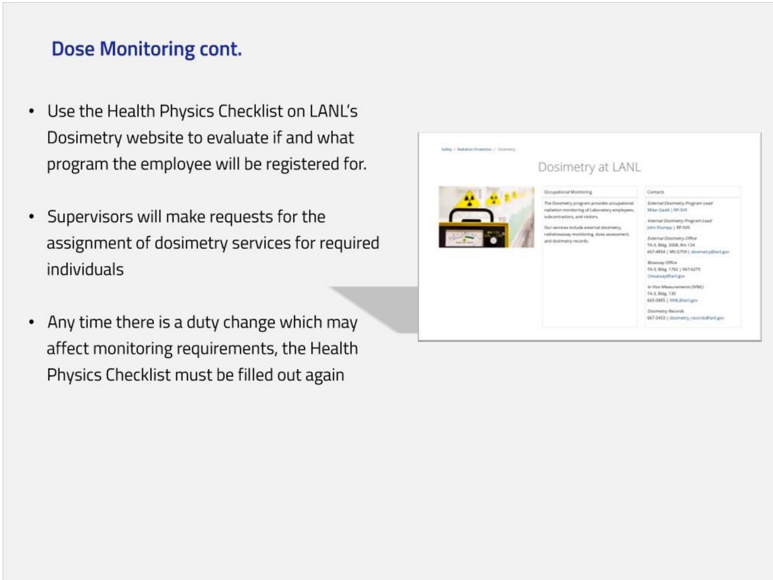


Narration: Dose monitoring is a required as part of LANL's radiation protection program. We are able to demonstrate to the DOE that LANL understands the radiological conditions in its controlled areas and has employed effective engineered and administrative controls to keep doses to personnel well below limits. Dose monitoring also enables the detection as radiological conditions changes as they arise.

For personnel, there are two ways that we conduct dose monitoring: 1.) through external dosimetry and the second is through internal bioassay. We will discuss each method in the next few scenes.

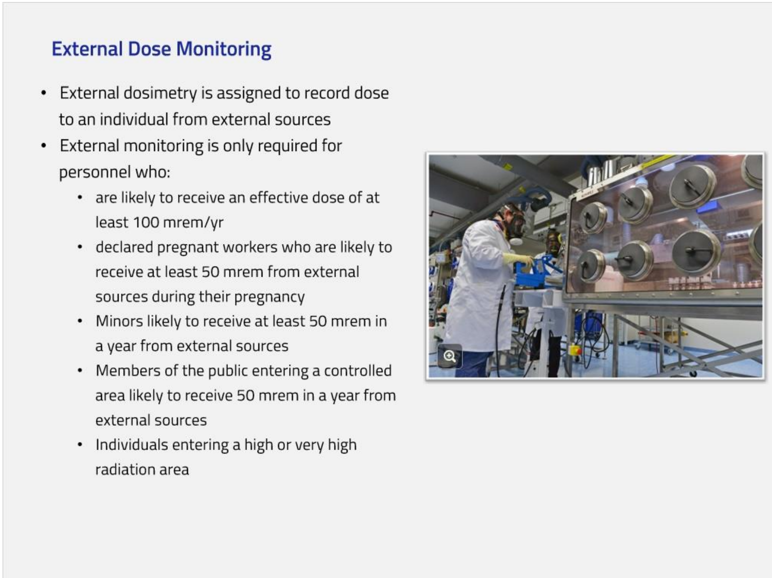
Not all personnel are monitored for dose. If you are not expected to receive more than a certain minimum dose based on your work situation and job tasks, you will not be enrolled in the dosimetry program. Dosimetry Services and your responsible line manager will determine whether or not to enroll you in the program.

1.36 Dose Monitoring cont.



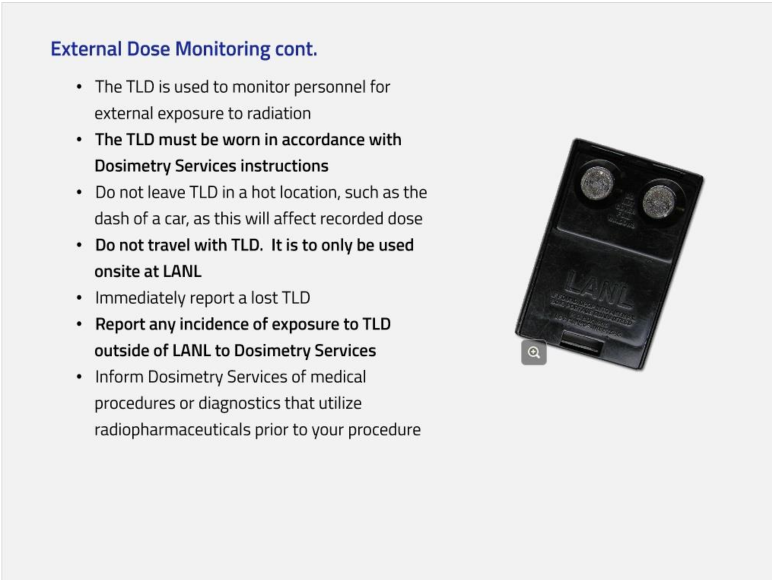
Narration: In order to determine if you need to be enrolled in LANL's dosimetry program, you will need to fill out the Health Physics checklist found on the Dosimetry website. This checklist will determine what monitoring programs you need to be enrolled in, if any. Your supervisor will make a request for permanent dosimetry if they expect that you will be performing tasks which require dosimetry or bioassay. If you change job roles or duties that may affect monitoring requirements, you must fill out the Health Physics checklist again to determine appropriate monitoring programs for your situation.

1.37 External Dose Monitoring



Narration: If you are likely to receive an effective dose of at least 100 mrem/yr, or you are a declared pregnant worker (*refer back to the RHAP program in lesson 2*) likely to receive 50 mrem per month throughout a term of pregnancy, a minor or a member of the public who will likely at least 100 mrem in a year, or any individual who enters a high or very high radiation area, you will be assigned external dosimetry.

1.38 External Dose Monitoring cont.

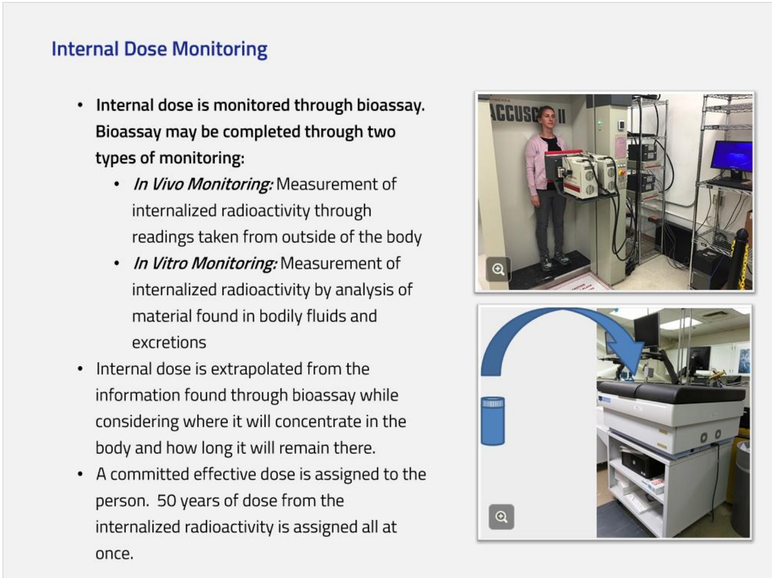


Narration: The thermo-luminescent dosimeter (TLD) is a dosimetry device assigned to personnel who are being monitored for external dose. It is important that the TLD be worn whenever an assigned individual enters a radiological area. The TLD must be worn as indicated by Dosimetry Services, typically on the center of the body between the neck and the waist.

- Do not leave the TLD in a hot location, such as the car dashboard. The heat will interfere with the TLD readout of its collected dose.
- Do not travel with the TLD. The TLD is expressly used at LANL for occupational dose received at this location. Report any incidents of exposure to the TLD outside of LANL to Dosimetry Services.
- If the TLD is lost, you must immediately report to Dosimetry Services so they may assign you a new dosimeter and interview you to estimate prior dose received.

If you are to receive a medical procedure or diagnostics involving radiopharmaceuticals, report to Dosimetry Services ahead of time so they can provide guidance regarding use of your TLD.

1.39 Internal Dose Monitoring



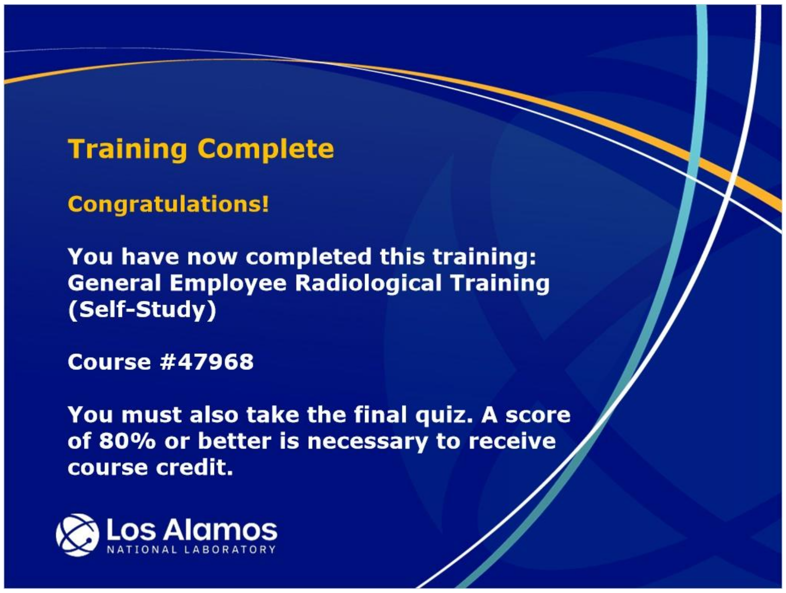
Narration: Internal dose is measured and applied differently than external dose. A bioassay is performed to assess radiation being emitted from within the body. Bioassays can be conducted on the entire-body, on the chest, thyroid, or wound counters in a process called in vivo monitoring. Samples of bodily fluids and excretions can be analyzed through a process called invitro monitoring. A committed effective dose based on what is found in the body will be assigned to the individual's dose of record. This takes into account the dose that will be received over the next 50 years from the radioactivity present in the system.

1.40 Exposure Reports

Narration: In the event that you are ever assigned dosimetry or to the bioassay program, your radiation doses will be recorded, and the records of your received doses will be maintained. Dose reports are provided to dosimetry enrolled

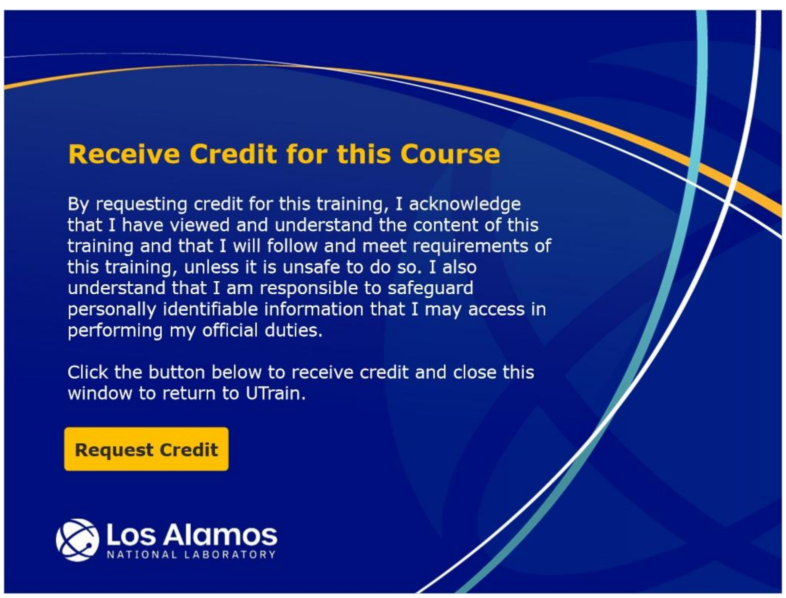
employees on an annual basis, and an entire dose history report is sent to personnel within 90-days of termination. Dosimetry results can be accessed anytime by following the "Request my dose history" or "Review my dosimetry results" links found on the LANL Dosimetry webpage. You may also request your dose records by sending an email to the dosimetry team at dosimetry_records@lanl.gov.

1.42 End of Course



Notes:

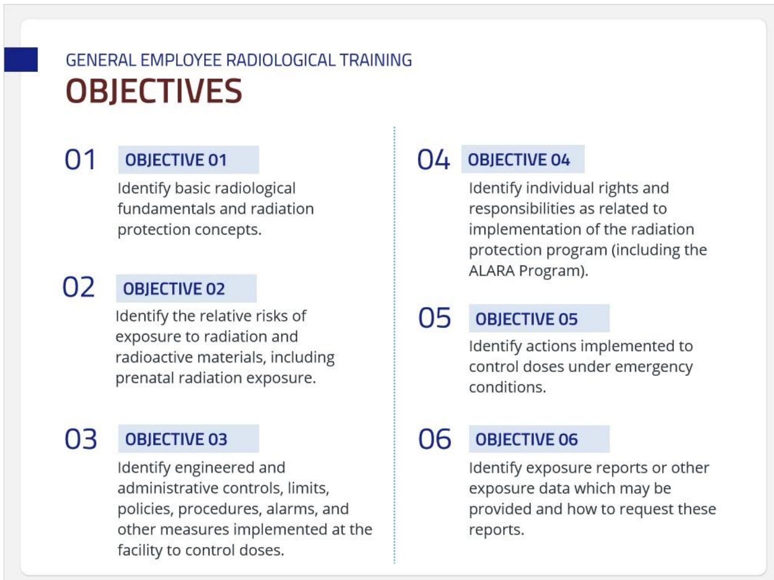
1.43 Exit



Notes:

2. Lightboxes

2.1 Objectives



Notes:

Take a moment to review the secondary objectives for this course. We focus on understanding the different roles and responsibilities within IWM, and how these responsibilities relate to the Safe Conduct of Research, or SCoR principles. We also want to make sure that you know the purpose of the Integrated Work Document (or Work Control Document) that is used throughout the work activity. You must use these documents to perform work in a safe, secure, and environmentally responsible manner.

2.2 Radiological Identification Systems